

THE CITRUS NEMATODE, TYLENCHULUS SEMIPENETRANS,  
BIOLOGY AND CONTROLJ. H. O'Bannon<sup>1</sup>

The first report of an association between a nematode and citrus appeared in 1889; however, it was not until 1912 when Tylenchulus semipenetrans Cobb was discovered on the roots of citrus trees in California that a nematode was found to cause a diseased condition of citrus, later called "slow decline." More than 60 years ago, Dr. N. A. Cobb predicted that the citrus nematode, as it came to be known, would someday become an important pest of citrus in Florida, if it were not controlled. His prediction has become a fact; surveys show the citrus nematode to be present in all citrus-growing areas worldwide and in 53% of Florida's groves. Because this nematode does not devastate citrus trees, its presence may not be immediately detected, but in time its effect on trees will become noticeable.

All citrus rootstocks used commercially are attacked by the citrus nematode. However, there are no obvious root symptoms to indicate the presence of this pest on nursery stock, and it often goes unnoticed, a factor accounting for its worldwide distribution. The major source of spread has been movement on infected nursery stock. A second source of infection is from replanting in old, infested grove sites.

Soil is an integral part of the infection process. Trees can become infested in almost any soil, but the degree of infection is related to soil type. The citrus nematode can attack trees much more rapidly and in greater numbers in fine-textured organic soils than in coarse-textured sands. Aboveground tree symptoms develop early on nematode-infected trees growing in organic soils, because nematodes increase rapidly in numbers, damaging and destroying roots early in the life of a tree, reducing its vigor. In contrast, aboveground symptoms may not be evident for many years on infected trees growing in deep, well drained sands, characteristic of the ridge area of central Florida. Here, the citrus nematode population increases slowly, and the root system grows at a rate about equal to the loss of infected roots. Although the root system under these conditions is more vigorous than that in organic soils, in time there is a higher population of nematodes that eventually takes its toll. We know that fruit losses from citrus nematodes in Florida may be as high as 140 boxes of fruit per acre of infected trees.

Life cycle - The life cycle consists of several stages, with the complete cycle from egg to egg requiring 6 to 8 weeks at 25 C. Eggs are laid in a gelatinous matrix by the female on the roots of citrus. The nematodes emerge from the eggs after about 12 to 14 days as second-stage larvae. The males undergo 4 molts, changing in length and width in 7 to 10 days. The males neither feed on

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nor infect roots. Females also undergo 4 molts to develop into immature females. Only the female becomes embedded in the root where it feeds on the cortical cells and develops to maturity. About one-fourth of the anterior portion of the female body is within the root, usually 4 to 5 cells deep, but never beyond the cortex (fig. 1). After a feeding site is established, the nematode's body becomes immobile, with its posterior portion exterior to the root. This portion, outside the root, becomes greatly enlarged at maturity (fig. 2).

Symptoms (root) - The citrus nematode does not cause galling or knots on the root. Females exude a gelatinous matrix that serves to protect the nematode eggs. Soil particles adhering to this matrix cause the infected roots to appear to have increased diameters. Actually, infected roots appear somewhat enlarged and have a very irregular rough surface irrespective of the adhering soil. The outer portion of such roots often separates readily from the axial portion, exposing the central cylinder.

Symptoms (aboveground) - Not all citrus trees having a high citrus nematode population on the roots show aboveground symptoms. Symptom expression may not be noticeable until 5 to 10 years after the peak of the nematode population is reached. However, aboveground symptoms, when they finally appear, consist of yellowing of leaves and general symptoms of malnutrition (sparse foliage, small, nonuniform fruit, and defoliated branch ends). Infected trees shed more leaves than do uninfected trees. This is particularly true during periods of environmental stress, such as those occurring in Florida during the low-rainfall season in the spring. The degree of decline may vary considerably from tree to tree. Generally, the correlation between nematode populations and decline symptoms is negative. Large populations of the parasite build up on the extensive roots of growing trees. These populations decrease rapidly as roots are damaged, become decayed, and decrease in number. Thus, trees in stages of decline may have lower populations of citrus nematodes than those with an abundance of roots on which the nematodes can feed. Under optimum conditions of cultivation, trees can live and produce with relative normality in spite of the presence of the nematode. If an imbalance between the soil and plant exists, however, the nematode becomes a factor which augments this imbalance. Eventually, trees will decline, resulting in a reduction of fruit yield and quality.

Nematode control (chemical) - Trees planted in infested old-grove soil become damaged and often show symptoms earlier than do infected trees planted in noninfested soil. To avoid this, preplant fumigation is important to the establishment of young, reset groves. Conventional chisel-fumigation equipment is used for overall treatment. Preplant fumigation, treating overall or one-half of the total area (12-1/2 ft if on a 25-ft spacing) where the trees will be planted with either DD mixture (1,3-dichloropropene, 1,2-dichloropropane and other related chlorinated C<sub>3</sub> hydrocarbons) or 1,3-D (1,3-dichloropropene and related chlorinated C<sub>3</sub> hydrocarbons),

is recommended for economic control.

Treating a reset site in a grove before transplanting a new tree can also be accomplished by basin application or chisel injection of chemicals to the site. Site treatment, using an inexpensive injector-probe that releases methyl bromide into the soil at one spot where it diffuses into the surrounding soil to a radius of at least 5 ft, has given effective nematode control. Preplant treatment will aid a tree in becoming established; however, a few nematodes will manage to survive. This results in an increased nematode population in time, thus requiring additional treatment after several years.

Treating citrus nematode-infested citrus groves in California, Arizona, and Texas is economically feasible and is recommended. Several field experiments for control of the citrus nematode on citrus trees in Florida have been conducted cooperatively with Dr. A. C. Tarjan, University of Florida, Agricultural Research and Education Center, Lake Alfred. DBCP (1,2-dibromo-3-chloropropane) applied through sprinkler irrigation or chisel injection at rates of 34 to 52 lb active ingredient per acre has given nematode control, resulting in yield increases of 1/2 to 1-1/2 boxes of fruit per tree.

Rootstock reaction - Certain selections or varieties of the trifoliolate orange, and some other plants botanically close to citrus, are highly resistant or immune to the citrus nematode. In California, trifoliolate orange and Troyer citrange rootstocks have been used in citrus nematode areas; however, a citrus nematode biotype that readily infects these rootstocks was discovered in California. Greenhouse screening tests conducted in Florida with Troyer citrange show it to be susceptible to the citrus nematode. Certain Poncirus trifoliolate (L.) Raf. selections, including Argentina, Large Flower, Pomeroy, and Rich, have exhibited a high degree of resistance to the citrus nematode in Florida. Recently, a morphologically indistinguishable biotype was found parasitizing a grass (but not citrus) in Florida.

Crop response - According to Cohn (1972), estimates of loss can be attained by measuring yield increases as a result of disease elimination through successful nematode control, and by comparing the performance of infected trees with that of uninfected trees. Data available on yield increases from citrus nematode control in various citrus-growing countries suggest a world average range of 20 to 30% increase in citrus yield. Because all infected citrus trees are not economically damaged by this nematode, Cohn suggests that the actual reduction in world citrus yields due to the citrus nematode could be estimated at 8.7 to 12.2%.

#### Literature Cited

Cohn, E. 1972. Nematode diseases of citrus. In J. M. Webster (ed.), *Economic Nematology*, pp. 215-244. Academic Press, London.

### Figure Legend

- Fig. 1. A photomicrograph of an adult female citrus nematode embedded in citrus root tissue magnified approximately 150 times.
- Fig. 2. Posterior portion of 2 adult female citrus nematodes extending from surface of root magnified approximately 85 times.



Figure 1



Figure 2